Modeling Flexible Exchange Rate USD / MAD

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Abstract: This article discusses the impact of the dirham’s flexibility on foreign exchange risk management and presents techniques for hedging this risk. The econometric approach used is the modeling of the flexible exchange rate USD / MAD

Keywords: exchange rate, Morocco, USD, MAD econometric, model

Abbreviation: TC: exchange rate

1. Introduction

In Morocco, the problem of currency risk did not arise to the extent that the exchange rate regime was fixed. From 1973, with the liberalization of foreign trade and the exchange rate regime, there is a shift from a uni-monetary anchoring system to a multi-monetary system from a basket of currencies of the main partners and a gradual shift of the Dirham followed by a devaluation of 16.50% in 1983, thus the modification of the weights of the basket respectively in 1980, 1999, 2001 and 2015.

The subject of the paper is a USD / MAD flexible exchange rate modelling test: methodology and empirical study using the Box and Jenkins model under Eviews. The article is composed of three sections, the first section deals with a review of the literature on exchange rate modelling, the second section will present the methodology in the third section, we will present application with the results of the estimation of the model Box and Jenkins and his various tests.

2. Literature Review

Foreign exchange risk is the risk of loss related to changes in exchange rates, these variations having a positive or negative effect on the flow of expenditure and revenue of the company which has repercussions on the cost of raw materials, revenues related to the sale of merchandise, but also financial flows relating to borrowing and investment in foreign currencies, the profitability of the enterprise and its book value. There are three types of foreign exchange risk, namely: foreign exchange transaction risk, accounting exchange risk and economic or operational currency risk.

Since 1994, emerging markets have suffered a succession of currency crises. A common feature of these crises is that they have hit countries that have chosen nominal pegging strategies based on the exchange rate. On the contrary, it appeared that emerging countries with no currency peg had escaped the contagion of currency crises. From this succession of crises emerged this consensus that intermediate exchange rate regimes could not constitute a credible policy.

The relevance of this new consensus has been the subject of intense debate. Empirically, numerous studies have shown the persistence of intermediate regimes even after the exchange crises of the 1990s (Levy-Yeyati and Sturzenegger (2005)); (Bénassy-Quéré and Coeuré (2000)); (Masson (2001)). Calvo and Reinhart (2001 and 2002), for their part, identified a fear of floating linked to the fact that currency depreciations do not have the same effects in emerging markets as in developed countries.

Frankel (1999 and 2004) challenged the theoretical under pinnings of this consensus, pointing out, on the one hand, that he ignores the fact that there is a wide spectrum in the possible choice of the degree of exchange rate flexibility and, on the other hand, given the variety of shocks that affect economies, and taking into account their evolution over time, thereis no a priori exchange rate regime that is optimal at any point in time. Authorities must therefore arbitrate between the benefits and costs of rigidity and flexibility.

One type excludes the presence of foreign currencies in the composition of the agents’ portfolio. This hypothesis, originally developed by Tobin in 1969, then taken up in a study by Branson, Halttunen and Masson in 1977, explains the portfolio reallocations that give rise to deficits or surpluses in the current account.

A second type, on the other hand, considers an economy in which the assets held by the agents are perfectly substitutable. More precisely, they hold indifferently in their portfolio the national currency or foreign currencies. It shows that substitution behaviours between currencies call into question the independence of monetary policies in a flexible exchange rate regime.

Section 2: Exchange Rate Modeling Methodology

To model the Moroccan flexible exchange rate, we will opt for the method of Box and Jenkins, this method inspired by the work of G. BOX and G. JENKINS (in the seventies) contributed a lot in theory and practice. Time series models. The objective to be answered in their book, "Time Series Analysis; Forecasting and Control ", is to build a random model ARMA type to reproduce the best achievements of a time series. The study of a series for forecasting, using the methodological approach of Box and Jenkins, goes through the following five steps:

HAOUAOUI. L, ALLERGET. JP, AYADI. M, « Un modèle de choix de régime de change: Aspects théoriques et analyse empirique », Tunis, 2006, P3

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Paper ID: ART20203687 DOI: 10.21275/ART20203687 1903
The study of stationarity (ADF tests, graphs)
Identification of the appropriate process (reading correlograms)
The estimation of the optimal model / process retained
Statistical inference (diagnosis / validation of the estimated model)
Prediction.

Data:
In order to conduct our work well, we will use bi-monthly data covering the period from January 2018 to December 2019. This period is characterized by a flexible exchange rate. The statistical database is collected from the Forex website. The data considered for this purpose fortnightly and the period chosen for January 16, 2018 which dates the beginning of the application of the flexible exchange rate regime in Morocco until December 16, 2018, so the series consists of 23 observations.

Section 3: Application
We will build an ARMA model from the exchange rate series. The study of the series through the approach of the method of Box and Jenkins allows us to better capture the best model that will be used to make these forecasts.

• Graphical analysis of the series:

Figure 1: Graph of the evolution of the exchange rate of the dollar against the dirham
Source: graph established by us under views using database (annexe 1)

The graph above describes the evolution of the flexible USD / MAD exchange rate from January 2018 to December 2018. This evolution seems to be characterized by an uptrend, in this case we will say that the TC series is not stationary, the graphic examination does not always make it possible to determine with certainty the existence of a trend. In order to remove the uncertainty, we use the correlogram and the Dickey-Fuller test.

• Analysis of the correlogram:

Table 1: Correlogram of the exchange rate of the dollar against

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We notice that simple autocorrelations are almost all different from zero and decrease slowly. The first partial autocorrelation is very significantly different from zero. This structure is that of a non-stationary series. Therefore, we use the Dickey-Fuller-Augmented Unit Root Test (ADF) which is the most relevant in the study the stationarity of the series.

• TC Stationarity Study: Unit Root Test
The Dickey-Fuller test allows us to test the stationarity of our series while taking into account the autocorrelation of disturbances. To do this, under Eviews, we will practice the unit root test for the three models specified by (ADF).

➢ Model 3: Pattern with trend and constant:
In this model, we test two hypotheses:
- H0: The absence of the trend;
- H1: The existence of a trend.

 Null Hypothesis: TC has a unit root
Exogenous: Constant, Linear Trend
Log Length 0 (Automatic - based on SIC, maxlag=4)

<table>
<thead>
<tr>
<th>Model 3: Pattern with trend and constant:</th>
</tr>
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<tbody>
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<td>In this model, we test two hypotheses:</td>
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<tr>
<th>t-Statistic</th>
<th>Prob *</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.904186</td>
<td>0.1800</td>
</tr>
</tbody>
</table>


Figure 2: Correlogram of the exchange rate of the dollar against
Source: graph established by us underviews

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Figure 3: TC Unit root test
Source: graph established by us underviews

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The series has a unit root since the probability is greater than 5% (P-value = 0.18>0.05), the trend is significant because the probability of the trend is less than 5% (P-value = 0.0145<0.05) we accept hypothesis H1: the existence of the tendency. Hence, the series is stationary of the Trend Stationary (TS) type. We move to model (2) according to the ADF test.

- Model 2: Model without trend and with constant:

In this model, we test two hypotheses:
- H0: The absence of the constant;
- H1: The existence of the constant.

Model 2: Model without trend and with constant:

In this model, we test two hypotheses:
- H0: The absence of the constant;
- H1: The existence of the constant.

The series is stationary because (P-value = 0.9230>0.05). So, we accept H0. To remove the trend, we propose to study the series with the following equation:

Estimation Command:

\[ \text{LS TC C @TREND} \]

Estimation Equation:

\[ TC = (1) + (2) @TREND \]

Substituted Coefficients:

\[ TC = 0.18766673913 + 0.0202866205534 @TREND \]

Note that the series obtained is a stationary series because (P-value = 0.00<5%).

• Modeling of the series without trend:
We find that the series fluctuates around the average, so the series is stationary.

• Identification of the ARMA model by the method of Box and Jenkins:

The DTC series is stationary, to identify the appropriate process in the ARMA family \((p, q)\) that is likely to reproduce the operating mode of the DTC series, we first refer to the correlogram of the stationary series DTC, then will judge the significance and goodness of the model.

To know the orders of the ARMA model \((p, q)\), we will use a correlogram of the stationary series DTC. Indeed, the simple correlogram allows us to identify a model AR \((p)\), while the partial correlogram allows to retain a model MA \((q)\). It can be seen from the correlogram that the terms are within the confidence interval and that all critical probabilities of the Ljung-Box statistic are greater than 5%. With the exception of the term AR \((1)\), MA \((1)\) and AR \((7)\).

• Estimation of the ARIMA model:

Let the model to be estimated: ARIMA \((7, 1, 1)\). We estimate the model under Eviews:
After estimating the model, the analysis of the significance of the coefficients leads to not keeping the model above because the probability is greater than 5%.

Let the model to be estimated: ARIMA (7, 1, 0). We estimate the model under Eviews:

- Validation of the model:
  - Autocorrelation test of residues;
  - Test of normality of residues

For this model to be statistically adequate, the perturbations must not be self-correlated. To verify this hypothesis, we use the Ljung-Box test:

We can observe that all the simple and partial autocorrelation terms are within the confidence interval and the gains associated with the Ljung-Box statistics are all greater than 5%. We do not reject the null hypothesis of non-correlation of errors. The correlogram therefore suggests that our residues follow a white noise.

- Forecast:
Equation of the obtained model:

Estimation Command:

\[ \text{LS(OPTMETHOD=OPG) DTC AR(7)} \]

Estimation Equation:

\[ \text{DTC} = 0 + [\text{AR}(7)]=C(1), \text{UNCOND}, \text{ESTML} = "1/12/2018 12/16/20" \]

Forecasting Equation:

\[ \text{DTC} = 0 + [\text{AR}(7)]=C(1), \text{UNCOND}, \text{ESTML} = "1/12/2018 12/16/20" \]

Substituted Coefficients:

\[ \text{DTC} = 0 + [\text{AR}(7)]=0.508046349229, \text{UNCOND}, \text{ESTMP} = "1/12/" \]

2019 exchange rate forecast

Figure 10: Graph of the exchange rate forecast USD / MAD in 2019

Source: graph established by us undereviews

Foreign exchange risk analysis within the company:

The analysis of the foreign exchange risk concerning the cash of the company "OLYMPE" consists in applying the exchange rates to the 2019 calendar to release the unrealized gains and losses on the debts.

Schedule of foreign suppliers:

Table 1: Foreign Debtors Debt Schedule in USD Currency.

<table>
<thead>
<tr>
<th>Date</th>
<th>Debt($)</th>
<th>Average historical price</th>
<th>Debt(MAD)</th>
<th>Forecast Eviews</th>
<th>Provisional disbursement</th>
<th>Forecast gain</th>
<th>Forecast loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/01/2019</td>
<td>8 178.43</td>
<td>9.55441</td>
<td>78 140.07</td>
<td>9.634289</td>
<td>78 793.36</td>
<td>0</td>
<td>-653.28</td>
</tr>
<tr>
<td>01/16/2019</td>
<td>8 436.00</td>
<td>9.53007</td>
<td>80 395.67</td>
<td>9.654576</td>
<td>81 446.00</td>
<td>0</td>
<td>-1 050.33</td>
</tr>
<tr>
<td>02/01/2019</td>
<td>16 637.08</td>
<td>9.53081</td>
<td>158 564.85</td>
<td>9.674862</td>
<td>160 961.45</td>
<td>0</td>
<td>-2 396.60</td>
</tr>
<tr>
<td>02/16/2019</td>
<td>51 692.49</td>
<td>9.53876</td>
<td>493 082.26</td>
<td>9.695149</td>
<td>501 166.39</td>
<td>0</td>
<td>-8 084.14</td>
</tr>
<tr>
<td>03/01/2019</td>
<td>106 091.89</td>
<td>9.55638</td>
<td>96 537.49</td>
<td>9.715435</td>
<td>1 030 728.86</td>
<td>0</td>
<td>-934 191.37</td>
</tr>
<tr>
<td>03/16/2019</td>
<td>78 527.10</td>
<td>9.59197</td>
<td>753 229.59</td>
<td>9.735722</td>
<td>764 518.02</td>
<td>0</td>
<td>-11 288.43</td>
</tr>
<tr>
<td>04/01/2019</td>
<td>70 254.00</td>
<td>9.66075</td>
<td>678 706.33</td>
<td>9.756009</td>
<td>685 398.66</td>
<td>0</td>
<td>-6 992.33</td>
</tr>
<tr>
<td>04/16/2019</td>
<td>401.5</td>
<td>9.59384</td>
<td>3 851.93</td>
<td>9.776269</td>
<td>3 925.17</td>
<td>0</td>
<td>-73.25</td>
</tr>
<tr>
<td>05/01/2019</td>
<td>2 790.92</td>
<td>9.64777</td>
<td>26 926.15</td>
<td>9.796582</td>
<td>27 341.48</td>
<td>0</td>
<td>-415.32</td>
</tr>
<tr>
<td>05/16/2019</td>
<td>6 093.54</td>
<td>9.64645</td>
<td>58 781.03</td>
<td>9.816869</td>
<td>59 819.48</td>
<td>0</td>
<td>-1 038.45</td>
</tr>
<tr>
<td>06/01/2019</td>
<td>103 191.68</td>
<td>9.70993</td>
<td>1 001 983.99</td>
<td>9.837155</td>
<td>1 015 112.55</td>
<td>0</td>
<td>-13 128.56</td>
</tr>
<tr>
<td>06/16/2019</td>
<td>83 227.80</td>
<td>9.66262</td>
<td>804 198.60</td>
<td>9.857442</td>
<td>820 413.21</td>
<td>0</td>
<td>-16 214.61</td>
</tr>
<tr>
<td>Total</td>
<td>535 522.43</td>
<td></td>
<td>2 343 397.96</td>
<td></td>
<td>5 229 624.63</td>
<td>0</td>
<td>-995 226.67</td>
</tr>
</tbody>
</table>

Source: established by us based on the forecast data
The foreign exchange risk graph explains large and recurring unrealized losses with a total of - 995 226 and latent gains not present.

- Currency risk analysis:

Table 2: Summary of the currency risk

<table>
<thead>
<tr>
<th></th>
<th>Debt ($)</th>
<th>Debt (MAD)</th>
<th>Provisional disbursement (MAD)</th>
<th>Forecast gain</th>
<th>Forecast loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>535 522,43</td>
<td>4 234 397,96</td>
<td>5 229 624,23</td>
<td>0</td>
<td>-995 226,67</td>
</tr>
<tr>
<td>%/ Debt (MAD)</td>
<td>123,50%</td>
<td>0%</td>
<td>23,50%</td>
<td></td>
<td>23,50%</td>
</tr>
</tbody>
</table>

The summary table of the foreign exchange risk shows that the total unrealized loss represents 25.50% of the total debt to be repaid and the total latent gain represents 0%.

- Flexible USD / MAD exchange rate volatility analysis

Table 3: Flexible USD / MAD exchange rate volatility

<table>
<thead>
<tr>
<th></th>
<th>Historical course</th>
<th>Forecast Eviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>9,53007</td>
<td>9,634289</td>
</tr>
<tr>
<td>Max</td>
<td>9,70993</td>
<td>9,857442</td>
</tr>
<tr>
<td>Average</td>
<td>9,62</td>
<td>9,745865</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0,08993</td>
<td>0,1115765</td>
</tr>
<tr>
<td>Coefficient of variation</td>
<td>0.9%</td>
<td>1.11%</td>
</tr>
</tbody>
</table>

The foreign exchange volatility analysis chart shows that the total unrealized loss returns on the one hand, at significant forward prices with an average of 9.745865 against lower historical prices with an average of 9.62. On the other hand, historical prices and forward prices are stable with a respective coefficient of variation of 0.9% and 1.11%.

3. Conclusion

Managers must therefore choose between the advantages and the obstacles of the fixity and flexibility of the exchange rate regime.

In a second section, we presented the methodological process of exchange rate modeling using the Box and Jenkins method. This is a method based on the study of a series for the purpose of forecasting, goes through the following five steps: the study of stationarity by ADF tests and graphics. Secondly, the identification of the appropriate process through the reading of the correlograms. Then, the estimation of the optimal model chosen to finally diagnose and validate the chosen model, which will allow to proceed to the forecast of the series.

It is in the last section that we try to answer the question around which this memoir is erected we are interested in series of exchange rate of the US dollar (USD) compared to the Moroccan dirham (MAD ), representing the official quotations of these spot parities collected from the Forex site over a period stretching from 16/01/2018 to 16/12/2018, characterized by the launch of the new flexible exchange rate regime. The volatility of the exchange rate forces the company studied to pay more attention to the hedging of the exchange rate risk thanks to the techniques offered on the interbank market mentioned above, since the exposure to currency risk increases more and more. because of the rise in forward exchange rates, which affects the cash flow of the company in question. Given this situation and in the absence of awareness of hedging instruments, futures (futures), currency options and currency swaps have been proposed as the most realistic instruments given the simplicity and availability of their implementations.

References


Annexe 1: data base.

<table>
<thead>
<tr>
<th>Date</th>
<th>Taux de change USD/MAD</th>
</tr>
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<tbody>
<tr>
<td>16/01/2018</td>
<td>9.21673</td>
</tr>
<tr>
<td>01/02/2018</td>
<td>9.15421</td>
</tr>
<tr>
<td>16/02/2018</td>
<td>9.11461</td>
</tr>
<tr>
<td>01/03/2018</td>
<td>9.26264</td>
</tr>
<tr>
<td>16/03/2018</td>
<td>9.17792</td>
</tr>
<tr>
<td>01/04/2018</td>
<td>9.20201</td>
</tr>
<tr>
<td>16/04/2018</td>
<td>9.19058</td>
</tr>
<tr>
<td>01/05/2018</td>
<td>9.29253</td>
</tr>
<tr>
<td>16/05/2018</td>
<td>9.41623</td>
</tr>
<tr>
<td>01/06/2018</td>
<td>9.48480</td>
</tr>
<tr>
<td>16/06/2018</td>
<td>9.45128</td>
</tr>
<tr>
<td>01/07/2018</td>
<td>9.42350</td>
</tr>
<tr>
<td>16/07/2018</td>
<td>9.46803</td>
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